Title: What is a Scatter Plot Saying?

Brief Overview:

This unit is designed to solidify students' understanding of creating, analyzing, and interpreting scatter plots. It starts out with the basic ideas of collecting data and making a scatter plot. It then focuses on analyzing the scatter plot to find relationships and interpret the data. This unit introduces major ideas of linear and non-linear relationships, the $y=x$ line, the line of best fit, and positive and negative relationships (association).

NCTM 2000 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

- **Content Standards**

Number and Operations
Students will demonstrate their ability to find relationships among numbers.

Algebra
Students will demonstrate their ability to identify linear and non-linear patterns, positive and negative associations, the $y=x$ line, and the line of best fit.

Measurement
Students will demonstrate their ability to apply appropriate techniques and tools to determine measurements.

Data Analysis and Probability

Students will demonstrate their ability to construct, analyze, and interpret a scatter plot.

- **Process Standards**

Problem Solving

Students will demonstrate their ability to solve problems by identifying scatter plots that have unfamiliar relationships

Reasoning and Proof

Students will demonstrate their ability to prove their opinions through mathematical justification.

Communication

Students will demonstrate their ability to communicate their understanding of positive and negative relationships.

Connections

Students will demonstrate their ability to connect what they know from real-life experiences to the data given.

Representation

Students will demonstrate their ability to represent data in a table, scatter plot, and through verbal expressions.

Grade/Level:

Grade 8, all learning levels except Algebra 1

Duration/Length:

Six 60 minute blocks

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Collecting data
- Analyzing univariant data (i.e., mean, median, mode, box plots, dot plots, histograms, bar graphs)
- Plotting ordered pairs on an coordinate grid
- Understanding information in a table
- Measuring various items in centimeters accurately

Student Outcomes:

Students will:

- Create scatter plots by hand and by calculator to represent data.
- Discover and identify linear and non-linear patterns.
- Discover and identify positive and negative relationships
- Identify when two variables have no relationship.

Materials/Resources/Printed Materials:

- Activity sheets (included)
- Tape measures
- TI-83+ calculators
- Two paper cups (one marked at 5 cm from the bottom and with a tiny hole in the bottom) for each group of students.
- Linguini (one piece per student)
- Rulers

Development/Procedures:

Activity #1

Materials needed for each student: Linguini
Ruler
Measuring tape (1 per group)

In this activity, students will measure their arm span and height, then combine their data as a class to get data points for their scatter plot. They will make a scatter plot by hand on the provided grid and then be led through questions that will help them to discover the trend of a line, whether it is linear or non-linear and what the $y=x$ line and line of best fit are (using the piece of linguini. Finally, they will interpret what this actually means in context with the real problem of how arm span and height are related.

Teacher notes:
Since these are new concepts, they will need to be guided through these questions. Help students to see the uphill trend of the line and that it is linear though it is not a perfect line. For measuring, we recommend hanging tape measures on the wall for easy measuring. Make sure to review accurate metric system measuring, how to plot ordered pairs on a coordinate grid, and how to make a graph using TAILS (Title, Axis, Increments, Labels, Spacing).

An answer key follows the Activity #1 sheets. A rubric is included in the back of the packet.

Activity #2

Materials needed for each student: linguini
Ruler
1 regular cup (per group)
1 cup marked at 5 cm from the bottom (per group)

Small glass or pitcher of water enough to fill the cup to the 5 cm mark (per group)

In this activity, students will experience what a negative relationship is. They will pour water into a cup with a small hole in the bottom of it and measure every twenty seconds how much water is left in the cup. (Depending on the level of the students, this can be done as a whole class demonstration.) Each group will then plot their individual data on the grid provided and again decide what the trend of the line is, whether it is linear or non-linear, and what the line of best fit is using the linguini. They will also think about whether a $y=x$ line is appropriate for this case. Finally, the students will then interpret the data to determine how water level and time left to drain are related.

Teacher notes:
Ahead of time, you will need to make a tiny hole with a toothpick in one cup per group and mark on that cup where 5 cm from the bottom is. Non-wax covered paper cups or styrofoam cups work best for this activity. Make sure paper towels are on hand for occasional spills or drips. Students should now be familiar with the terminology and should be able to analyze the graph with little help. Provide assistant to those students who still need help analyzing and interpreting the graph. Make sure to compare this trend to the trend of Activity #1.

An answer key follows the Activity #2 sheets. A rubric is included in the back of the packet.

<u>Activity #3</u>
Materials needed for each student: TI-83+ Calculator (or similar variety)
Rulers
Linguini

This activity includes all three types of relationships (positive, negative, and none) so it is a bit longer. This time, the data sets are included and students will read the data in the table, use it to answer questions, and make a scatter plot on their calculator (see calculator notes). They will go through the same process of explaining the trend, drawing a line of best fit, and assessing whether a $y=x$ line is appropriate. Finally they will conclude what this analysis means for the data.

Teacher notes:
Students need to be able to make the graph on the calculator. If this is a new activity, the calculator notes can be run off and given to the students as you demonstrate. If the students are familiar with this, then simply review it with students. At this point, students should be able to analyze and interpret the graphs to determine the relationships between the variables. Provide help for those students who still have trouble with this. In this activity, students will also be given a graph with no relationship. Direct a discussion and lead students to see that sometimes two variables are not related.

An answer key follows the Activity #3 sheets. A rubric is included in the back of the

packet.

Performance Assessment:

Materials needed for each student: TI-83+ calculators
Linguini
Ruler

Students will answer questions and make predictions from a data table and then create a scatter plot on their TI-83+ calculator and then sketch the graph on paper. They will determine if the line is linear or non-linear and what type of relationship it represents and why. The students will also need to find a line of best fit for the calculator. Finally, the students will have to interpret the graph and determine what the relationship means in context to the problem.

Teacher notes:
This is designed to assess students' understanding of analyzing and interpreting scatter plots.

An answer key follows the Performance Assessment sheets. A rubric is included in the back of the packet.

Extension/Follow Up:

-Research manatee data (see Part B on Activity #3).
-Find and test other variables that have a positive, negative, or no relationship.
-Find data through magazines, the internet, or other sources and predict what type of relationship they have.
-Research other sets of data that are not linear and discover why they don't form a line.

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Height vs. Arm Span

Part A - *Introduction*

Have you wondered if height is related to arm span? Is there a relationship? In this activity, you will discover the answer to this question!

As you grew in height, do you think your arm span changed? Explain your prediction.

_____
_____
_____
_____

Part B – *Collecting Individual Data*

With a partner and a tape measure, measure each of your arm spans and heights in centimeters (to the nearest half-centimeter). Record your information in the table below.

Name	Height (cm)	Arm Span (cm)

Part C – *Collecting Class Data*

After your teacher has collected the class data, record the information in the table below.

Height (cm)	Arm Span (cm)

Height (cm)	Arm Span (cm)

Part D – *Predicting*

1) We have worked with data for bar graphs, box plots, dot plots, and histograms. What is different about that data and our data about height and arm span?

_____
_____
_____
_____

2) When you have two sets of data, it is called BIVARIANT data. When you have two sets of something, what can we do with them?

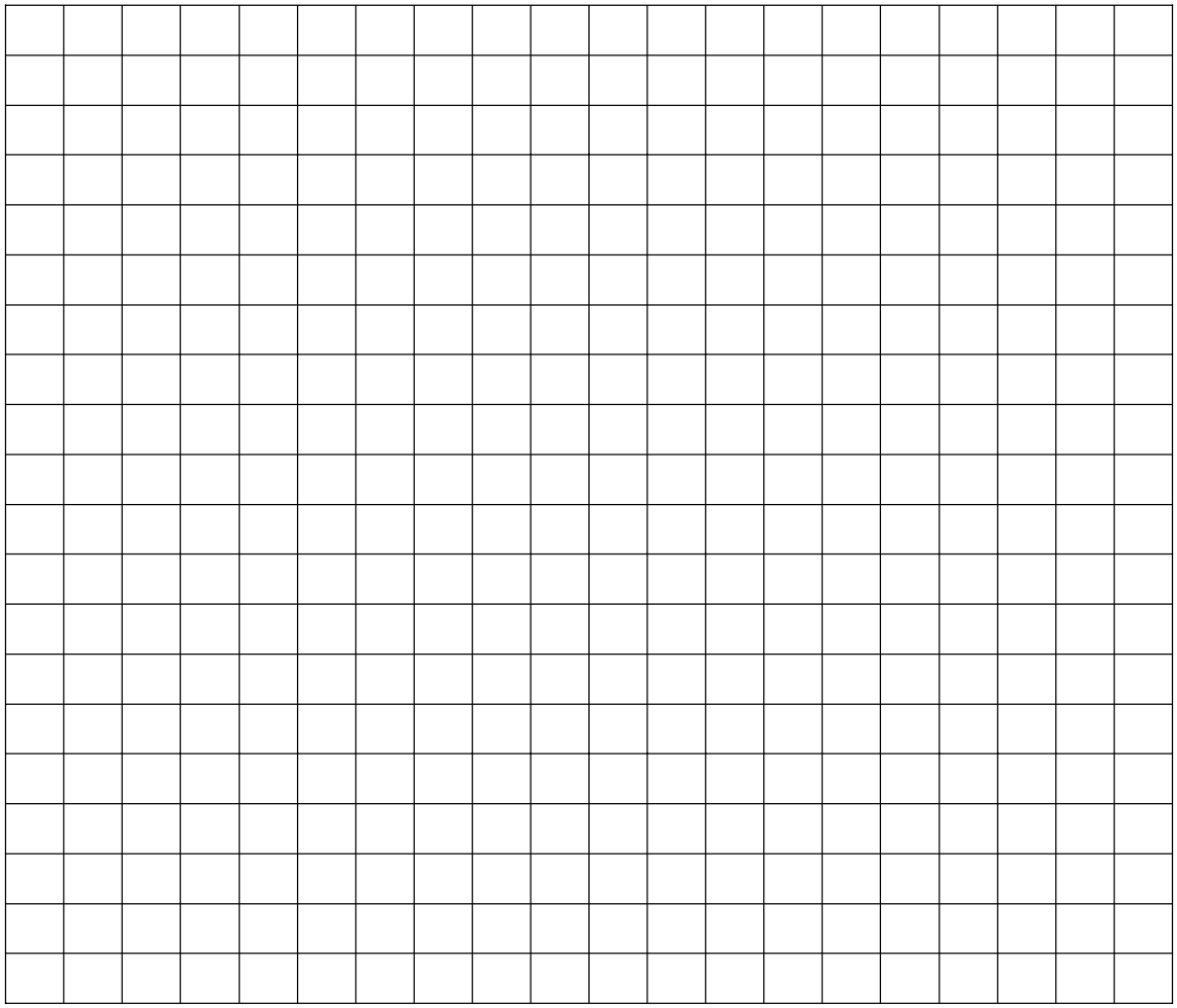
_____
_____
_____

3) When we compare, we are looking for a relationship between the two variables. From your data gathering, what prediction can you make about the relationship?

_____
_____
_____
_____

Part E - *Organizing the Data*

Organize the data into a scatter plot (height, arm span). Make sure to use TAILS!
(Don't forget which variable goes on the *x*-axis and which goes on the *y*-axis!)



Part F- *Analyzing Trend*

1) What do you notice about the trend of the points on the scatter plot? (Hint: think of uphill and downhill)

_____
_____
_____
_____

*When the data points are going uphill, this is called a **positive relationship**. When the data points are going downhill, this is called a **negative relationship.** This is called the **trend** of the data.*

4) In a positive relationship, as the *x*-variable (height) increases, the *y*-variable (arm span) _____ (increases or decreases).

5) In a negative relationship, as the *x*-variable increases, what do you think the *y*-variable will do? _____ (increase or decrease)

6) Height and arm span is an example of a _____ relationship. Write a sentence to justify why this is a positive relationship between height and arm span.

_____
_____
_____
_____

7) Was your prediction from Part A about the relationship between these two variables correct? _____

Part G – *Analyzing the y=x line*

1) Look back at the class data. Was there anyone who had the same height and the same arm span? What were their ordered pairs?

_____

_____

2) What are five other possible ordered pairs where height is the same as arm span?

Ordered Pairs (x, y)

3) Plot those points on your scatter plot in a different color. Connect these points to form a line.

4) This line is called the ***y=x line***. Why do you think it is called this?

_____

_____

_____

_____

5) Look at several points above the line. What do you notice about the arm span compared to height?

_____
_____
_____

6) Look at several points below the line. What do you notice about the arm span compared to height?

_____
_____
_____

7) The points above the line represent people who…

_____

8) The points below the line represent people who…

_____

Part H – *Analyzing the Line of Best Fit*

1) Do you think the $y=x$ line you drew in Part G "fits" the data well? Are there too many points above or below the line? Explain.

_____
_____
_____

2) Lay a piece of linguini on your graph and place it where you think it would be the best "fit" line. Justify why you placed it there.

_____
_____
_____

3) In a different color, trace this ***line of best fit*** on your graph. Compare your line of best fit to other students in your class.

This graph shows a linear relationship, where the data follows the trend of a line. Not all data follows this trend. We will look at data that does not follow this trend in another activity.

Part I – *Interpreting the Data*

Now that we have collected, organized, and analyzed the data, what can you conclude about height and arm span?

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_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Height vs. Arm Span
Teacher's Answer Sheet

Answers for Parts A – E will vary

Part F- *Analyzing Trend*

1) What do you notice about the trend of the points on the scatter plot? (Hint: think of uphill and downhill)

The data follows an uphill trend. It starts with low *x* values and low *y* values. As *x* values increase, *y* values increase.

*When the data points are going uphill, this is called a **positive relationship**. When the data points are going downhill, this is called a **negative relationship.** This is called the **trend** of the data.*

1) In a positive relationship, as the *x*-variable (height) increases, the *y*-variable (arm span) **increases** (increases or decreases).

2) In a negative relationship, as the *x*-variable increases, what do you think the *y*-variable will do? **decrease** (increase or decrease)

3) Height and arm span is an example of a **positive** relationship. Write a sentence to justify why this is a positive relationship between height and arm span.
It is a positive relationship because as your height increases, your arm span also increases.

4) Was your prediction from Part A about the relationship between these two variables correct? **Many correct answers**

Part G – *Analyzing the y=x line*

Answers for questions 1- 3 will vary

4) This line is called the ***y=x line***. Why do you think it is called this?
It is called the *y = x line* because all *x* values equal all *y* values.

5) Look at several points above the line. What do you notice about the arm span compared to height?
The arm span for that person is greater than the height of that person.

6) Look at several points below the line. What do you notice about the arm span compared to height?
The height for that person is greater than the arm span for that person.

7) The points above the line represent people who…
have a greater arm span than height.

8) The points below the line represent people who…
have a greater height than arm span.

Part H – *Analyzing the Line of Best Fit*

Answers for Question 1 will vary.

2) Lay a piece of linguini on your graph and place it where you think it would be the best "fit" line. Justify why you placed it there.

I placed the line of best fit there because it followed the trend of the data. Also, there were some points above and below the line.

Part I – *Interpreting the Data*

Now that we have collected, organized, and analyzed the data, what can you conclude about height and arm span?

After looking at the data, the graph displayed a positive relationship. As height increased, arm span increased in a linear fashion.

Draining Water

Part A – *Introduction*

In the last activity, you found that there was a positive relationship between height and arm span, so as your height increases so does your arm span. In this activity, we are going to look at the relationship between amount of water in a cup and the amount of time it takes the water to drain out of the bottom of the cup.

Predict what type of relationship exists between these two variables. In other words, as time increases, what is happening to the amount of water in the cup?

_____
_____
_____
_____

Part B – *Collecting Data*

1) In groups, assign one person to hold the cup that is marked five centimeters from the bottom. This cup has a small hole in the bottom so the person holding it also needs to put their finger over the bottom.

2) Have one person pour water into the cup until it fills up to the five centimeter mark. (The person holding the cup should keep his/her finger over the hole.)

3) When one person is ready with a timer, have the person holding the cup remove his/her finger and let the water drip into the extra cup. The time person should start the stopwatch as soon as the hole is open.

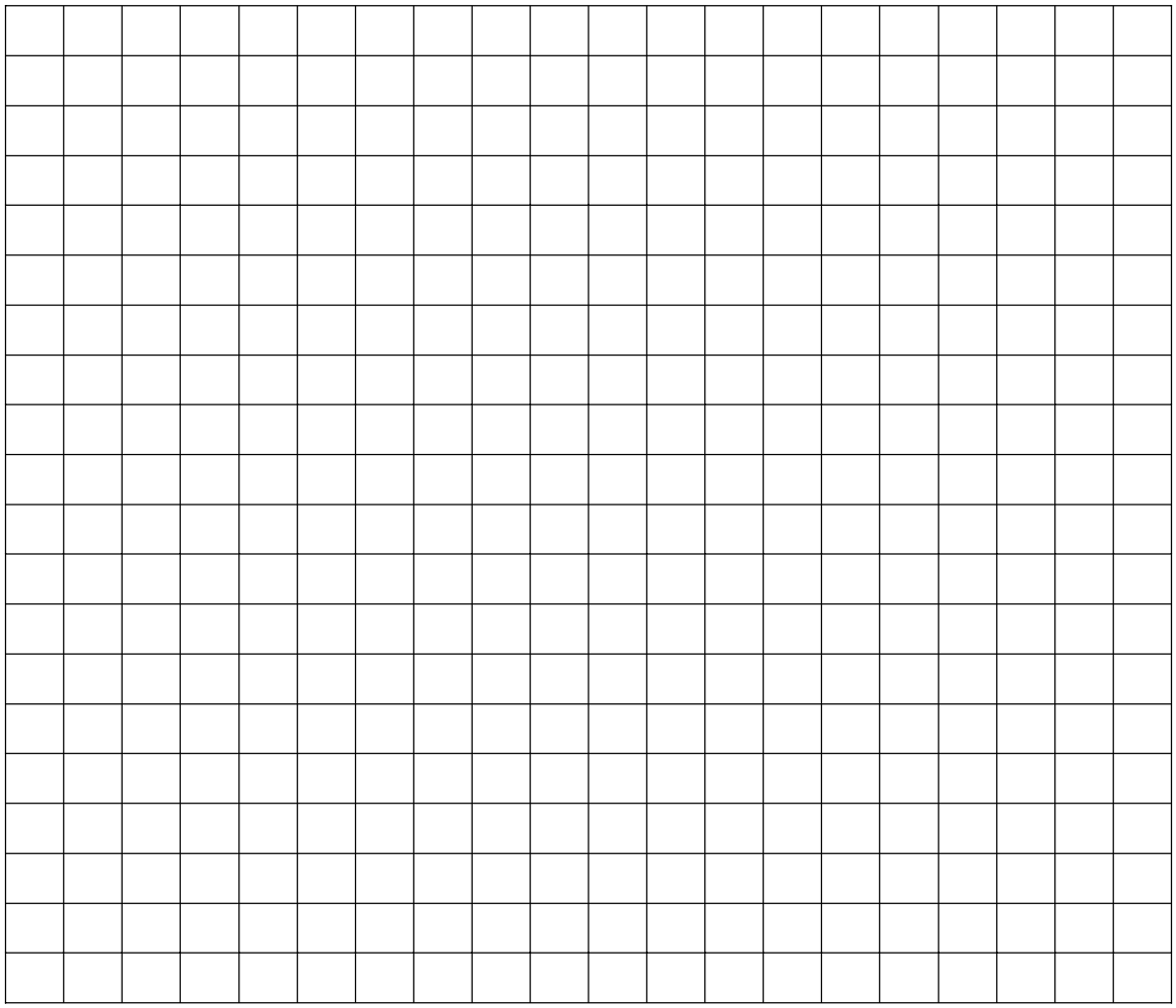
4) Every twenty seconds, mark on the outside of the cup where the water level is until the water is completely drained.

5) Measure each mark in centimeters on the cup and record the water level in the table below.

Time (seconds)	Centimeters of Water Left in Cup

Part C – *Organizing the Data*

Organize the data into a scatter plot (time, water level). Make sure to use TAILS!



Part D - *Analyzing the Data*

1) Explain the trend of the scatter plot. What type of relationship is this? Is it linear? Use mathematics to justify your answer.

_____
_____
_____

2) How is this different from the scatter plot comparing height and arm span? Use mathematics to justify your answer.

_____
_____
_____

3) Does it make sense to draw the $y=x$ line on this graph? What would that represent? Use mathematics to justify your answer.

_____
_____
_____

4) Using a piece of linguini, find a line of best fit that represents this data. Then, using a different color, draw your line of best fit on your scatter plot.

5) Explain why you chose this line of best fit.

_____
_____
_____

Part E – *Interpreting the Data*

1) Was your prediction from Part A correct about the relationship between time left to drain and water level? Explain.

_____
_____
_____

2) From what you seen in the scatter plot, what can you conclude about the relationship between time left to drain and water level?

_____
_____
_____

Draining Water
Teacher's Answer Sheet

Answers for Parts A – C will vary. The scatter plot in Part C should show a negative relationship.

Part A – *Introduction*

3 pts for predicting the type of relationship

Part B – *Collecting Data*

1 pt for completing the data chart

Part C – *Organizing the Data*

3 pts for the scatter plot

Part D - *Analyzing the Data*

1) Explain the trend of the scatter plot. What type of relationship is this? Is it linear? Use mathematics to justify your answer. **(3 pts)**
   The data follows a downhill trend. The data has a negative relationship. As *x* values increase, *y* values decrease. The data is linear.

2) How is this different from the scatter plot comparing height and arm span? Use mathematics to justify your answer. **(3 pts)**
   The scatter plot with height and arm span was a positive relationship. The data followed an uphill trend. The draining water data follows a downhill trend.

3) Does it make sense to draw the y=x line on this graph? What would that represent? Use mathematics to justify your answer. **(3 pts)**
   No. The *y* = *x* line would represent the time elapsed equaling the amount of water left in the cup. For example,

5 seconds passing would mean there is 5 centimeters of water in the cup. This would be a positive relationship.

4) Using a piece of linguini, find a line of best fit that represents this data. Then using a different color, draw your line of best fit on your scatter plot. **(1 pt)**

5) Explain why you chose this line of best fit. **(3 pts)**
I chose this line of best fit because it follows the downhill trend of the data. It has some points above and below the line.

Part E – *Interpreting the Data*

1) Was your prediction from Part A correct about the relationship between time left to drain and water level? Explain. **(3 pts)**
Answers will vary

2) From what you seen in the scatter plot, what can you conclude about the relationship between time left to drain and water level? **(4 pts)**
As time increases, the water level in the cup decreases in a linear fashion.

Data Analysis

Part A – *Tornado Data*

The table below shows data about Tornadoes in North America from the time frame of 1979 to 1990.

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Number of Tornadoes	852	866	783	1046	931	907	684	764	656	702	856	1,133
Number of Lives Lost	84	28	24	64	34	122	94	15	59	32	50	53

Source: "Almanac of World Facts" by Rand McNally (1994)

1) How many tornadoes were there in 1988 in North America?

   _____

2) In which year was the least amount of lives lost from tornadoes?

   _____

3) Do you think there is a relationship between the number of tornadoes and the number of lives lost? If yes, predict the relationship. Explain your answer.

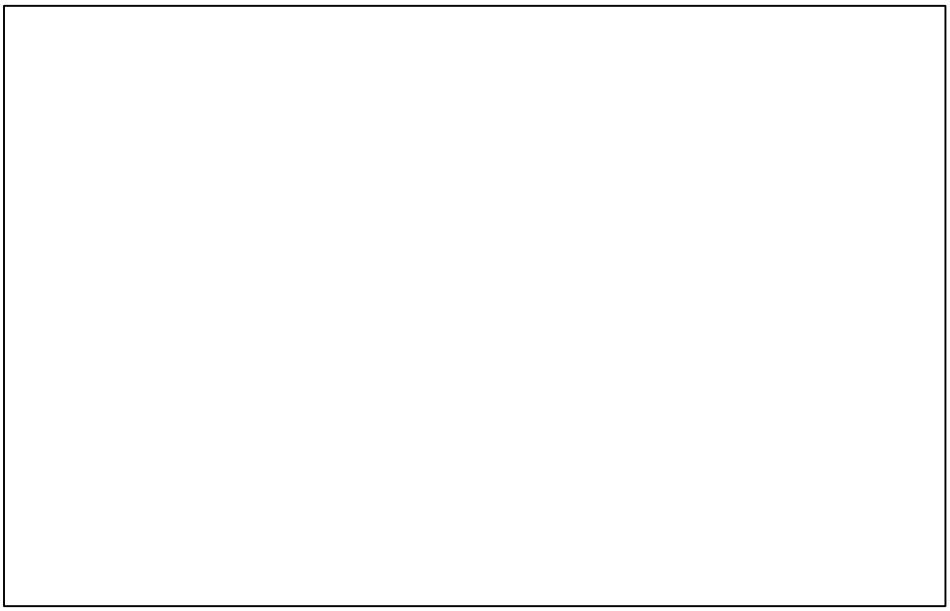
   _____

   _____

   _____

4) Using a TI-83 calculator, organize the data into a scatter plot. (Number of tornadoes, Number of Lives Lost)

5) Sketch the graph below. Use TAILS!



6) Explain the trend displayed in the scatter plot. What type of relationship is this? Is it linear? Use mathematics to justify your answer.

_____
_____
_____
_____

7) How is this different from the other scatter plots we have graphed? Use mathematics to justify your answer.

_____
_____
_____

8) Does it make sense to draw the $y=x$ line on this graph? Use mathematics to justify your answer.

_____
_____
_____

9) Was your prediction (from Question 3) of the relationship about the number of tornadoes and the number of lives lost correct? Explain.

_____
_____
_____

10) After analyzing the tornado data, what can you conclude about the relationship between the number of tornadoes and the number of lives lost?

_____
_____
_____
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_____
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Part B – *Manatee Data*

The table below shows the number of powerboat registrations and the number of manatees killed during the time frame of 1977 to 1990.

Year	Powerboat Registrations	Manatees Killed
1977	447	13
1978	460	21
1979	481	24
1980	498	16
1981	513	24
1982	512	20
1983	526	15
1984	559	34
1985	585	33
1986	614	33
1987	645	39
1988	675	43
1989	711	50
1990	719	47

Source: "Introduction to the Practice of Statistics," by Moore and McCabe, 2nd edition

Note: Powerboat Registrations are given in thousands of boats.

1) How many powerboat registrations were there in 1984? What does this mean? How many manatees killed?

_____

_____

2) Do think there is a relationship between the number of powerboat registrations and the number of manatees killed in a year? If yes, predict this relationship. Explain your answer.

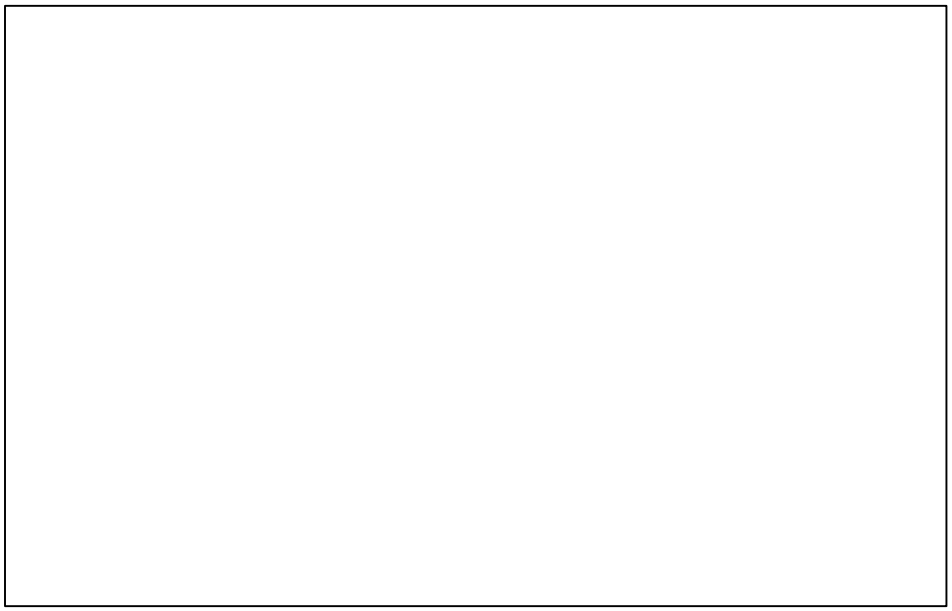
_____

_____

_____

3) Using a TI-83 calculator, organize the data into a scatter plot. (Powerboat Registrations, Manatees Killed)

4) Sketch the graph below. Use TAILS!



5) Explain the trend displayed in the scatter plot. What type of relationship is this? Use mathematics to justify your answer.

_____
_____
_____
_____

6) Is the data linear or non-linear? Justify your answer.

_____
_____
_____
_____

7) Does it make sense to draw the $y = x$ line on the graph? What would that represent? Use mathematics to justify your answer.

_____
_____
_____

8) Lay a piece of linguini on the scatter plot where the line of best fit should be. Using a different color, draw your line of best fit on the scatter plot.

9) Explain why you chose this line of best fit.

_____
_____
_____

10) Was your prediction (from Question 2) of the relationship about the number of powerboat registrations and number of manatees killed correct? Explain.

_____
_____
_____

11) After analyzing this data, what can you conclude about the relationship between the number of powerboat registrations and the number of manatees killed?

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_____

Extension

12) Why do you think the table stops at the year 1990? Why does it not go through the year 2002?

_____

_____

_____

_____

13) Research manatee history in the early 1990's to see what might have changed the trend you saw in the manatee data.

Part C – *Water Cooling Data*

The following data is from a student experiment. The experiment started with a cup of water at room temperature. Ice was added and the temperature of the water recorded as time elapsed.

Time Elapsed (sec)	Temperature of Water (ºC)
0	85.5
10	81
20	76.8
30	72
40	69.3
50	67.1
60	65.1
70	63.7
80	62.2
90	61.2
100	60.6
110	60.1
120	59.5
130	59.4

1) How many minutes and seconds elapsed from the beginning to the end of the experiment?

_____

2) Do think that there is a relationship between the time elapsed during cooling and the temperature of the water? If yes, predict the relationship. Explain your answer.

_____
_____
_____
_____

3) Using a TI-83 calculator, organize the data into a scatter plot. (Time Elapsed, Temperature of Water)

4) Sketch the graph below. Use TAILS!

5) Explain the trend displayed in the scatter plot. What type of relationship is this? Use mathematics to justify your answer.

_____
_____
_____
_____

6) Is the data linear or non-linear? Justify your answer.

_____
_____
_____
_____

7) Does it make sense to draw the $y = x$ line on this scatter plot? What would that represent? Use mathematics to justify your answer.

_____
_____
_____

8) Lay a piece of linguini on the scatter plot where the line of best fit should be. Using a different color, draw your line of best fit on the scatter plot.

9) Explain why you chose the line of best fit.

_____
_____
_____

10) Was your prediction (from Question 2) of the relationship between the time elapsed during cooling and the temperature of the water correct? Explain.

_____
_____
_____

11) After analyzing this data, what can you conclude about the relationship between the time elapsed during cooling and the temperature of the water?

_____
_____
_____
_____
_____
_____
_____
_____
_____

Data Analysis
Teacher's Answer Sheet

Part A – *Tornado Data*

1) How many tornadoes were there in 1988 in North America? **(1 pt)**

702

2) In which year was the least amount of lives lost from tornadoes? **(1 pt)**

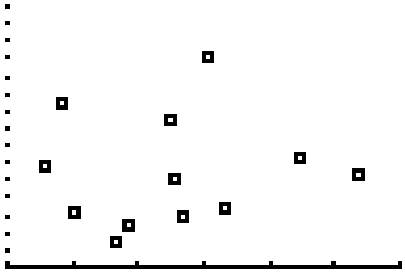
1986

3) Do you think there is a relationship between the number of tornadoes and the number of lives lost? If yes, predict the relationship. Explain your answer. **(3 pts)**

Answers will vary.

4) Using a TI-83 calculator, organize the data into a scatter plot. (Number of tornadoes, Number of Lives Lost)

5) Sketch the graph below. Use TAILS! **(3 pts)**



6) Explain the trend displayed in the scatter plot. What type of relationship is this? Is it linear? Use mathematics to justify your answer. **(3 pts)**
The data is neither uphill nor downhill. The data is scattered all over the screen. It does not have a positive or negative relationship. The graph is not linear.

7) How is this different from the other scatter plots we have graphed? Use mathematics to justify your answer. **(3 pts)**
The other graphs had a positive or negative relationship. This graph does not have any relationship.

8) Does it make sense to draw the $y=x$ line on this graph? Use mathematics to justify your answer. **(3 pts)**
No. The $y = x$ line would represent the number of tornadoes for a certain year equaling the number of lives lost by tornado that year. This would be a positive relationship. The tornado data has no relationship.

9) Was your prediction (from Question 3) of the relationship about the number of tornadoes and the number of lives lost correct? Explain. **(3 pts)**
Answers will vary.

10) After analyzing the tornado data, what can you conclude about the relationship between the number of tornadoes and the number of lives lost? **(4 pts)**
Each year the number of tornadoes had no effect for on the number of people who died from that tornado.

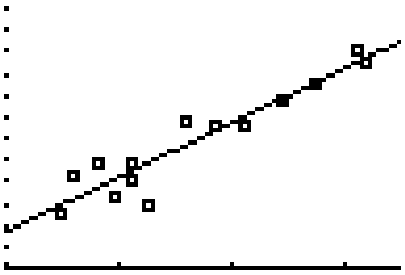
Part B – *Manatee Data*

1) How many powerboat registrations were there in 1984? What does this mean? How many manatees killed? **(2 pts – 1 for 559,000 and 1 for 34)**
   There were 559,000 people whole owned a powerboat registration. 34 manatees were killed in 1984.

2) Do think there is a relationship between the number of powerboat registrations and the number of manatees killed in a year? If yes, predict this relationship. Explain your answer. **(3 pts)**
   Answers will vary

3) Using a TI-83 calculator, organize the data into a scatter plot. (Powerboat Registrations, Manatees Killed)

4) Sketch the graph below. Use TAILS! **(3 pts)**



5) Explain the trend displayed in the scatter plot. What type of relationship is this? Use mathematics to justify your answer. **(3 pts)**
   There is an uphill trend in the data which is a positive relationship.

6) Is the data linear or non-linear? Justify your answer. **(3 pts)**
   The data is scattered to form a line, so it is linear.

7) Does it make sense to draw the $y = x$ line on the graph? What would that represent? Use mathematics to justify your answer. **(3 pts)**
No, it would not make sense to draw the $y = x$ line. The line would mean that if there were 500 manatee deaths then there would be 500 powerboat registrations.

8) Lay a piece of linguini on the scatter plot where the line of best fit should be. Using a different color, draw your line of best fit on the scatter plot. **(1 pt)**

9) Explain why you chose this line of best fit. **(3 pts)**
Answers will vary.

10) Was your prediction (from Question 2) of the relationship about the number of powerboat registrations and number of manatees killed correct? Explain. **(3 pts)**
Answers will vary

11 After analyzing this data, what can you conclude about the relationship between the number of powerboat registrations and the number of manatees killed? **(4 pts)**
As more people got powerboat registration, the number of manatee deaths increased.

Extension

12) Why do you think the table stops at the year 1990? Why does it not go through the year 2002?
Answers will vary.

13) Research manatee history in the early 1990's to see what might have changed the trend you saw in the manatee data.
In the early 90's, legislation was passed in Florida to protect the manatee's from getting killed from powerboats.

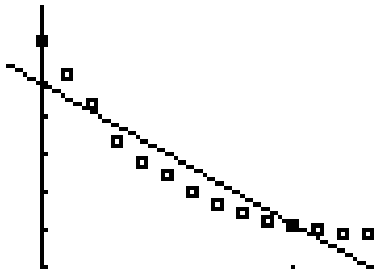
Part C – *Water Cooling Data*

1) How many minutes and seconds elapsed from the beginning to the end of the experiment? **(1 pt)**
Two minutes and 10 seconds elapsed

2) Do think that there is a relationship between the time elapsed during cooling and the temperature of the water? If yes, predict the relationship. Explain your answer. **(3 pts)**
Answers will vary.

3) Using a TI-83 calculator, organize the data into a scatter plot. (Time Elapsed, Temperature of Water)

4) Sketch the graph below. Use TAILS! **(3 pts)**



5) Explain the trend displayed in the scatter plot. What type of relationship is this? Use mathematics to justify your answer. **(3 pts)**
The data follows a downhill trend, so it has a negative relationship.

6) Is the data linear or non-linear? Justify your answer. **(3 pts)**
The data does not follow the shape of a line. It seems to be a curve. The data must be non-linear.

7) Does it make sense to draw the $y = x$ line on this scatter plot? What would that represent? Use mathematics to justify your answer. **(3 pts)**
No, it does not make sense to draw the $y = x$ line. This line would mean that if 10 seconds elapsed, then the temperature of the water would be 10°C.

8) Lay a piece of linguini on the scatter plot where the line of best fit should be. Using a different color, draw your line of best fit on the scatter plot. **(1 pt)**

9) Explain why you chose the line of best fit. **(3 pts)**
Answers will vary.

10) Was your prediction (from Question 2) of the relationship between the time elapsed during cooling and the temperature of the water correct? Explain. **(3 pts)**
Answers will vary.

11) After analyzing this data, what can you conclude about the relationship between the time elapsed during cooling and the temperature of the water? **(4 pts)**
As time goes by, the temperature of the water decreases.

Performance Assessment
Scatter Plots

The following data is a list of 21 countries with the cigarette consumption per adult per year and then number of deaths per 100,000 people per year from coronary heart disease (CHD).

Country	Cigarette Consumption per Adult per Year	CHD Mortality per 100,000 (Ages 35-65)
United States	3,900	257
Canada	3,350	212
Australia	3,220	238
New Zealand	3,220	212
United Kingdom	2,790	194
Switzerland	2,780	125
Ireland	2,770	187
Iceland	2,290	111
Finland	2,160	233
West Germany	1,890	150
Netherlands	1,810	125
Greece	1,800	41
Austria	1,770	182
Belgium	1,700	118
Mexico	1,680	32
Italy	1,510	114
Denmark	1,500	145
France	1,410	60
Sweden	1,270	127
Spain	1,200	44
Norway	1,090	136

Part A – *Looking at the Data*

1) Which country had the highest cigarette consumption?

_____
_____
_____

2) Did this country have the highest CHD Mortality?

_____
_____
_____

3) Which country had the lowest cigarette consumption?

_____
_____
_____

4) Did this country have the lowest CHD Mortality?

_____
_____
_____

5) Do you think cigarette consumption and CHD mortality have a relationship? If yes, predict this relationship. Explain your answer.

_____
_____
_____

Part B – *Organizing the Data*

On your calculator, organize the data into a scatter plot. Sketch the graph below. (Cigarette Consumption, CHD Mortality) Use TAILS!

Part C – *Analyzing the Data*

1) Explain the trend displayed in the scatter plot. What type of relationship is this? Use mathematics to justify your answer.

_____
_____
_____

2) Is the data linear or non-linear? Justify your answer.

_____
_____
_____

3) Does it make sense to draw the $y=x$ line? What would that represent? Use mathematics to justify your answer.

_____
_____
_____

4) Draw a line of best fit on your scatter plot. Explain why you chose to place it there.

_____
_____
_____

5) Was your prediction (from Part A) of the relationship between cigarette consumption and CHD mortality correct? Explain.

_____
_____
_____

Part D – *Interpreting the Data*

After analyzing the data, what can you conclude about the relationship between cigarette consumption and CHD mortality?

_____
_____
_____
_____
_____
_____

Performance Assessment
Scatter Plots
Teacher's Answer Sheet

Part A – *Looking at the Data*

1) Which country had the highest cigarette consumption? **(1 pt)**
The United States had the highest cigarette consumption per adult per year.

2) Did this country have the highest CHD Mortality? **(1 pt)**
Yes, the United States had the highest mortality.

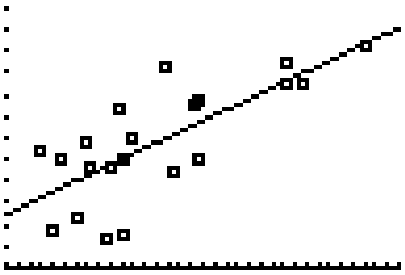
3) Which country had the lowest cigarette consumption? **(1 pt)**
Norway had the lowest cigarette consumption per adult per year.

4) Did this country have the lowest CHD Mortality? **(1 pt)**
No, Norway did not have the lowest CHD Mortality. Mexico had the lowest mortality

5) Do you think cigarette consumption and CHD mortality have a relationship? If yes, predict this relationship. Explain your answer. **(3 pts)**
Answers will vary. A possible answer many be: I think cigarette consumption and CHD mortality is related because countries with higher cigarette consumption aslo have high CHD mortality.

Part B – *Organizing the Data*

On your calculator, organize the data into a scatter plot. Sketch the graph below. (Cigarette Consumption, CHD Mortality) Use TAILS! **(3 pts)**



Part C – *Analyzing the Data*

1) Explain the trend displayed in the scatter plot. What type of relationship is this? Use mathematics to justify your answer. **(3 pts)**
There is an uphill trend in the data which is a positive relationship. As *x* values increase, *y* values also increase.

2) Is the data linear or non-linear? Justify your answer. **(3 pts)**
The data is scattered to form a line, so it is linear.

3) Does it make sense to draw the $y=x$ line? What would that represent? Use mathematics to justify your answer. **(3 pts)**
No, it does not make sense to draw the $y = x$ line. This would mean the number of people smoke is the number of people who die from smoking. Not everyone who smokes will die from CHD.

4) Draw a line of best fit on your scatter plot. Explain why you chose to place it there. **(3 pts)**
Answers will vary.

5) Was your prediction (from Part A) of the relationship between cigarette consumption and CHD mortality correct? Explain. **(3 pts)**

Answers will vary.

Part D – *Interpreting the Data*

After analyzing the data, what can you conclude about the relationship between cigarette consumption and CHD mortality? **(4 pts)**

As more people smoke cigarettes, more people die from CHD.

Rubric

3 point

3- Selects and applies appropriate mathematical skills/strategies.
Uses mathematical terminology precisely.
Uses a wide variety of ways to represent mathematical ideas to clarify.
Draws mathematically correct conclusions.

2- Sometimes selects and applies appropriate mathematical skills/strategies.
Uses adequate mathematical terminology.
Uses a limited variety of ways to represent mathematical ideas.
Mathematical conclusion is sometimes correct.

1- Mathematical skills and strategies are ineffective.
Misuses appropriate mathematical terminology.
Represents mathematical ideas incorrectly.
Incorrect conclusion shown.

0- Mathematical skills and strategies are not recorded.
Does not use mathematical terminology.
Does not represent mathematical ideas.
No conclusion shown.

4 point

4- Selects and applies appropriate mathematical skills/strategies.
Uses mathematical terminology precisely.
Uses a wide variety of ways to represent mathematical ideas to clarify.
Draws mathematically correct conclusions.

3- Mostly selects and applies appropriate mathematical skills/strategies.
Uses correct mathematical terminology most of the time.
Uses a limited variety of ways to represent mathematical ideas.
Mathematical conclusion is mostly correct.

2- Sometimes selects and applies appropriate mathematical skills/strategies.
Uses adequate mathematical terminology.
Uses one way to represent mathematical ideas.
Mathematical conclusion is sometimes correct.

1- Mathematical skills and strategies are ineffective.
Misuses appropriate mathematical terminology.
Represents mathematical ideas incorrectly.
Incorrect conclusion shown.

0- Mathematical skills and strategies are not recorded.
Does not use mathematical terminology.
Does not represent mathematical ideas.
No conclusion shown.

Calculator Notes

The following directions are for the TI-83 plus calculator. The activities and directions can be modified for the use of other graphing calculators.

Making a Scatter plot

1. Go into the list function by pressing 2^{nd} and STAT.
2. Highlight EDIT and hit ENTER. This will take you to your lists.
3. In L_1, enter your data for the *x*-variable (enter the number and then hit ENTER)
4. In L_2, enter your data for the *y*-variable.
5. Go to your stat plot function by hitting 2^{nd} and Y=.
6. Make sure Plot 1 is highlighted and then hit ENTER to go into Plot 1.
7. In Plot 1, highlight ON and hit ENTER.
8. Hit the down arrow and highlight the scatter plot function and then hit ENTER.
9. Hit the down arrow and put L_1 (hit 2^{nd} 1) is next to the xlist and L_2 (hit 2^{nd} 2) is next to the *y* list.
10. Hit the down arrow and choose what type of dot you would like the calculator to use in the scatter plot.
11. Go to the window function by hitting WINDOW.
12. Choose appropriate measures for *x*-min (your smallest *x* value), *x*-max (your largest *x* value), and *x*-scl (what the scale on the *x*-axis should be). Hit ENTER after each entry.
13. Choose appropriate measures for *y*-min (your smallest *y* value), *y*-max (your largest *y* value) and *y*-scl (what the scale on the *y*-axis should be). Hit ENTER after each entry.
14. Leave the *x*-res at 1.
15. Hit GRAPH and your scatter plot should appear. It you want a wider or different view, go back to window and change the values to what is needed and then hit GRAPH again.
16. You can trace through the points by hitting TRACE and then using the arrow keys.